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Potato Starch

R. H. Treadway

Nearly 10% of the potato crop is normally made up of substandard potatoes unsuitable for the tablestock market because they are either too small, too large, misshapen, or damaged. Nearly all the cull and surplus potatoes not fed to livestock are used in starch manufacture.

Potato and wheat were the leading domestic starches early in the nineteenth century. According to Brautlecht (1940), the first potato starch plant in the United States was established in 1831 at Antrim, New Hampshire. By about 1880 there were more than 150 potato starch factories operating in Maine, New Hampshire, Vermont, Michigan, Wisconsin, Ohio, and Minnesota (Anon. 1940). The industry, from its early history to the present, has been largely made up of numerous small plants instead of several large factories, as we find in cornstarch manufacture. Many years ago in Maine and other states, special cultivars of potatoes were grown for starch manufacture. These were not of outstanding culinary quality but contained a relatively large amount of starch. In the Netherlands and Germany, different types of poatoes are still grown for tablestock and for industrial uses.

During the middle of the nineteenth century and somewhat beyond, the starch industry was one of the principal outlets for potatoes grown in the northeastern part of the United States. According to Brautlecht (1953), 30% of the 5 million bushels of potatoes grown in Maine in 1883 were used in starch production, 60% for food, and the rest retained for seed.

Except for the early period, potatoes have never brought at the starch factory a price commensurate with the growing cost. Since the yield of starch is not much more than one-tenth the weight of the potatoes ground, factory operators generally could not pay more than about 35 cents/100 lb of potatoes and sold starch for 6–7 cents/lb at the plant. This price relationship prevailed during a long period until the sharply elevated prices reached by potatoes and starch in 1973–1974. In spite of the fact that potatoes to be used for starch production must be sold by the grower at a low price, starchmaking has been regarded as an integral part of a healthy potato industry. Diversion of cull and surplus potatoes to starch factories has done much to improve the quality of tablestock potatoes and establish more orderly marketing in the potato industry.

Late in the nineteenth century, potato starch lost its strong position in the general field to cornstarch, which could be sold at a lower price. Potato starch then entered the category of specialty starches. Brautlecht (1940) reported that by 1900 the number of potato starch factories had decreased to 63. A decided trend developed toward concentrating the potato starch industry in Aroostook County, Maine, where 45 of the nation's plants were located around the turn of the century. Northern Maine became a center for production of tablestock and seed potatoes, with the starch industry providing an outlet for the culls. In 1920 there were about 20 factories in Maine with a combined daily capacity of somewhat less than 75 tons of starch. Although the total productive capacity of Maine's starch industry increased markedly after that time, owing to the construction of new plants and modernization of existing facilities, the number of plants did not increase.

The history of American potato starch can be summarized as follows:

1. The period from about 1850 to about 1900, in which it was a leading all-purpose starch.
2. The period from about 1900 to late in the 1930s when potato starch was relegated to a specialty starch greatly overshadowed by corn and tapioca starches. During this interval much of the high-quality potato starch used by American industry was imported.
3. The period after World War II in which an upsurge occurred in the production of potato starch. Large quantities of starch have been produced from most of the potato crops since 1950. A revival in the general usage of this starch has made it competitive with cornstarch, to a certain extent, in several applications. However, it should be kept in mind that over ten times as much cornstarch as potato starch is used.

Potato starch production is confined to the northern states where late-crop potatoes are stored throughout the winter. It would be difficult to operate a plant economically unless it has raw material available over a period of several months each year. The operating season, or *campaign*, is from about October to about June of the following year, around 200 operating days. Rarely, though, is the supply of cull potatoes sufficient and distributed so that plants can operate at capacity throughout the season.

The high point in potato starch production in Maine was reached in 1956–1957 when 114 million pounds were produced (Page 1957). Since then, both total production and the number of plants has decreased. Potato starch production was inaugurated in Idaho late in 1941 with the establishment of plants at Blackfoot and Twin Falls (Beresford and Aslett 1945). The number of plants in Idaho increased to eight in the 1950s, with productive capacity about the same as in Maine at that time. As in Maine, however, the number of plants and production has declined since then.

The decline in potato starch production from the highs of the mid- and late-1950s is clearly due to two factors: (1) food processors found it economical to use potatoes that are sound but below the rigid standards of the fresh tablestock market, and (2) the thrust toward improvement of the water quality in streams has presented a serious problem to the starch processor. Thus, the starchmaker has to compete with the food processor for much of his raw material and is faced with the need for expensive waste treatment facilities. As a result, many of the nation's potato starch factories have closed.

Two modern starch plants were built in 1954–1955—one at Moses Lake, Washington, having a 35-ton capacity and another at Monte Vista, Colorado, having a 25-ton capacity. A second plant was established later at Monte Vista and also one at Grafton, North Dakota.

During the past 10 years the amount of potato starch produced in the United States from year to year has varied considerably, but no trend in the amounts manufactured during this period has developed. In general, larger yearly crops provide greater quantities of call and surplus potatoes for starch manufacture and smaller crops reduce the potato supply to starch plants. Waste water disposal is still a major problem for starch plants.

PRODUCTION METHODS

Although potatoes present more problems in storage and handling than does corn, they are definitely easier to process for starch recovery. In the wet processing of corn, the grain must be steeped, i.e., soaked for about 48 hr in warm water acidified with sulfur dioxide. Steeping is necessary primarily to soften the kernel so that the various constituents may be separated. Corn also must be passed through a special mill to remove the germ of the kernel. The degerminated corn is then passed through buhr mills to disintegrate the tissue and permit separation of fiber from starch and gluten.

Potatoes, in contrast, are milled directly after leaving the washer. Either a rasp or a hammer mill is used to disintegrate potato cells and liberate the starch. The skin and fiber are then separated from the starch by screening. Final purification is similar in both corn and potato starch manufacture. Removal of the water solubles is effected by washing, and the remaining insoluble impurities are separated by any one of several types of equipment that utilize the difference in specific gravity between the starch and impurities.

A photomicrograph indicating the general nature of the tissue that must be disintegrated during milling is shown in Fig. 15.1. The cross section is from a low-starch potato sliced from the center of the tuber, where the starch content is quite low. In this particular section the tissue contains only perhaps 5%. However, for the purpose of illustrating how potato cells are grouped together and for the manner in which starch granules are packed in the cells, it is preferable to examine a section containing relatively little starch. The walls of potato cells fit closely to one another with only occasional air spaces, in a pattern similar to a honeycomb cross section. The several more tightly packed

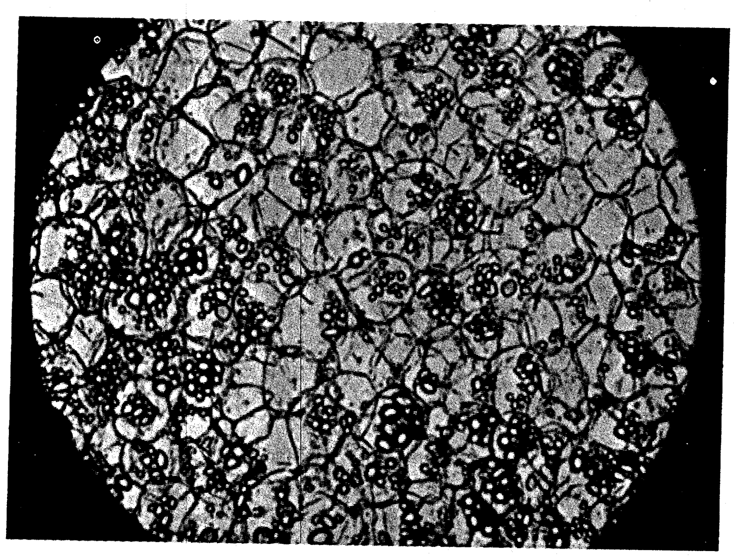

Fig. 15.1. Section sliced from the pithy area of raw potato tuber showing starch granules (× 52).

cells shown in the illustration are typical of potatoes used in starch manufacture.

Maine Plants

There is great variation in the processing details and in the equipment used to produce potato starch. Some of the oldest Maine plants use quite simple equipment with which the operators rasp the potatoes, screen off the fibrous material, settle the starch in vats, wash the starch by resuspending and resettling, dewater the starch and dry it. Many older plants have modernized to a greater or lesser degree. But even with modernized plants and those built in recent years, there is wide latitude in selection of equipment and in arrangement of the individual steps comprising the processing.

What might be considered a typical Maine factory produces about 10 tons of starch a day while consuming 80–90 tons of potatoes. Potatoes processed in Maine starch factories contain, on average, about 13% starch (Table 15.1), whereas those processed in Idaho plants have a somewhat higher starch content, about 15–16%.

A typical starchmaking operation in a Maine plant of about 10-ton capacity is illustrated in Fig. 15.2. Although this operation is not the most modern, it is efficient and turns out a high-quality product. Starch plants in Maine usually have storage facilities for handling at least 10,000–12,000 bushels of potatoes at the factory. The potatoes are removed from the storage bin by means of a flume, which carries them to a conveyor and at the same time removes stones and much dirt. The conveyor lifts the potatoes up to the washer, where the remaining dirt is removed. The potatoes are then elevated to a hopper from which they fall to a screw conveyor that regulates the raw material flow to the rasp. The rasp reduces the potatoes to a slurry. The slurry is diluted with water to facilitate subsequent screening. Sulfur dioxide is added at this stage to inhibit the action of oxidative enzymes

Table 15.1. Estimated Average Composition of Potatoes Processed in Maine Starch Factories

Substance	Amount (%)
Starch	13
Protein (N×6.25)	2
Cellulosic material	1.5
Sugars	0.5
Mineral (ash)	1
Miscellaneous minor constituents (total)	1
Water	81

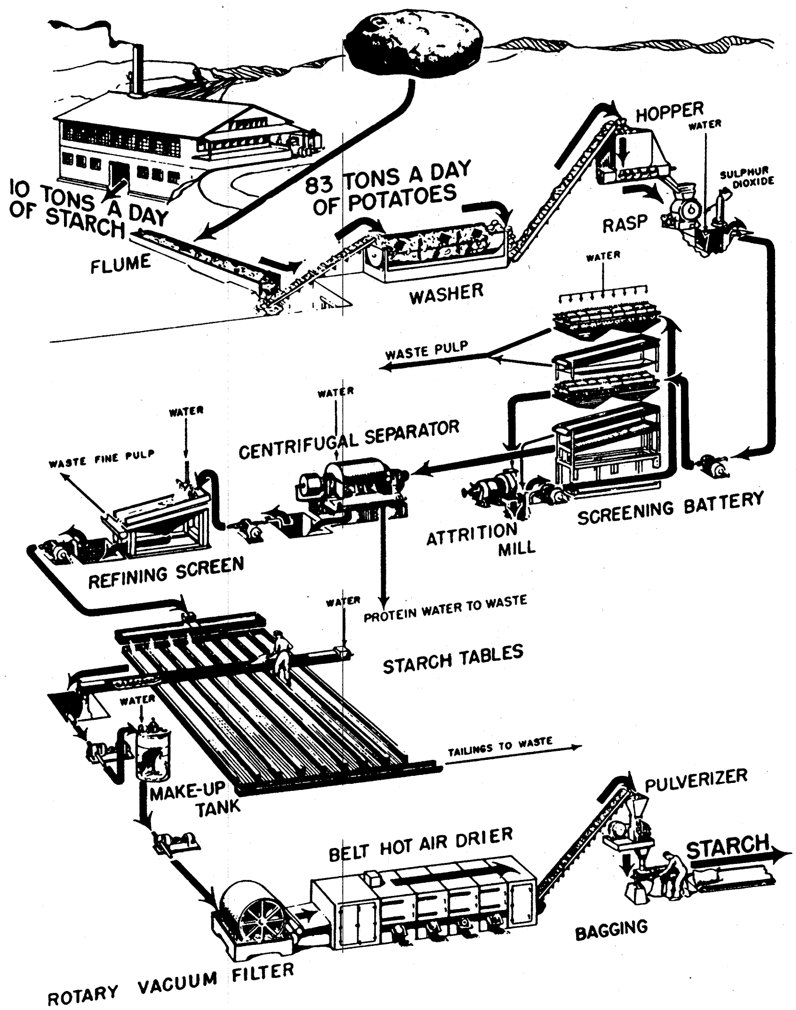

Fig. 15.2. Flow diagram for manufacture of potato starch using screening battery and tables.

and thereby aid in producing a white starch. The dilute slurry is pumped to a battery of screens on which most of the cellulosic material is retained while the starch passes through.

The screening battery consists of screens and sieves mounted vertically in the following order: lower shaker screen (80-mesh), lower rotary brush sieve (perforated with 0.03-in.-diameter holes), upper shaker screen (100-mesh), and upper rotary brush sieve (perforated with 0.02-in.-diameter holes). In the screening operation, the starch is first pumped onto the bottom sieve. Here the starch and water pass through and the pulp is discharged off the end of the sieve. The pulp is diluted with water and drops into an attrition mill for a second grinding to release a further quantity of starch. The starch suspension, with the fine pulp that passed through the lower sieve, falls onto the lower shaker screen. The starch granules pass through, and most of the fine pulp is discharged from the end of the screen later to be mixed with the reground pulp from the attrition mill. The combined pulp is then pumped to the upper sieve where it is washed with a water spray. The fine pulp and starch pass through this sieve and drop onto the upper shaker screen. The starch suspension passes on through to the lower shaker screen. The fine pulp from the upper shaker screen and coarse pulp from the upper sieve are joined to constitute what is called the *pomace,* or waste pulp, which is discharged to the sewer.

The starch suspension from the screening battery is then pumped to a centrifugal separator where the *protein water,* i.e., wash water containing the soluble materials, is removed. The starch from the continuous centrifuge is diluted with water and pumped to a refining screen (120-mesh), which removes additional fine pulp. The starch suspension is then pumped to tables where the starch settles and the remaining traces of fiber and soluble substances flow off at the end.

The starch cake is scraped from the tables and then diluted to the proper density for pumping to the continuous rotary vacuum filter. After dewatering to about 40% moisture, the cake is dried in a continuous-belt drier to about 17% moisture. The finished starch has approximately the following percentage composition on a dry basis: starch, 98–98.5; ash, 0.3; and cold-water-soluble compounds, 0.1. It contains about 0.5% fibrous material and traces of nitrogen compounds and sugars. For a more complete discussion of potato starch processing, see Howerton and Treadway (1948) and Muller (1941).

Maine plant operators have made definite contributions toward improved technology in potato starch manufacture, extending throughout all phases. Thus, potato maceration was early accomplished by a homemade rasp constructed of a hollow, wooden drum covered with punched sheet metal. Steel rasps fitted with sawtooth blades on the surface parallel to the axis of the drum were later introduced. Hammer mills were also employed for the grinding of the potatoes and attrition mills for grinding the once-extracted pulp. The oldest Maine plants washed the starch in wooden vats. This practice gave way to use of concrete vats. Tables were later used to settle the starch from the processing water. Dewatering of starch was later improved by use of centrifuges or vacuum filters. Maine processors have made much progress in starch-drying methods, proceeding from open-air drying on racks in stove-heated drying houses to the adoption of rotary "turbo" (ring story) and more recently of continuous-belt driers.

Idaho Plants

Idaho processors have also made their share of contributions toward advances in potato starch production methods. They were first to grind potatoes using a type of disintegrator that combines features of a centrifuge with a vertical hammer mill. In this disintegrator, a vertical rotor with hammers in horizontal plane rotates at high speed within a 360° screen enclosure. The potato macerate is swirled against the perforated cylinder, and the finely comminuted pulp is forced through the holes. Most of the Idaho plants use similar equipment and procedures. Following disintegration of the potatoes, the pulp is screened to separate the free starch and then reground to liberate more starch. Screens ranging from 80- to 120-mesh are used to separate the coarse fiber, and 120- to 150-mesh screens remove much of the fine fiber. Horizontal, continuous centrifugals are used to remove the protein water. Settling vats are usually employed for removing the small quantity of remaining fine fiber and insoluble impurities that settle at the top in the so-called brown starch layer. The purified starch is dewatered by rotary vacuum filters.

Idaho plant operators pioneered in the use of *cyclone flash* driers. Although there is some variation in the numbers of stages and in the air temperature used, conditions employed in one of the leading plants can serve as an illustration. Predrying of the moist starch from the vacuum filter is effected in a screw conveyor through which air at 143°C passes countercurrently. The partially dried starch then drops into a high-speed blower where it is mixed with 143°C air. The moisture-laden air and starch are separated in a cyclone dust collector. This is repeated by passing the starch through three additional blowers and cyclone separators. A fifth blower–cyclone cools the starch before bagging. The following advantages are claimed for flash drying: (1) less capital investment relative to other driers; (2) less fuel requirement; and (3) more flexible control of moisture content of finished product.

Modern Plants

Figure 15.3A outlines all the principal operations in a typical modern starchmaking plant, and Fig. 15.3B shows the details of the purification, separation, and final operations. The disintegrator is of the vertical hammer mill type, the action of which was described in the preceding discussion of Idaho plants. Centrifugal rotating sieves, first used in Europe, have been installed in several modern U. S. factories. In construction, they bear some resemblance to a centrifugal pump, but with slotted sieve plates in place of the impeller vanes. The pulp slurry enters the rotating sieve through a central feed pipe and then flows radially outward along sieve plates. Centrifugal force drives the starch milk through the slots in the sieve plates, from which it is discharged through an outlet. The coarse pulp, which cannot pass through the slots, is discharged through a separate outlet. Several centrifugal sieves are usually employed in series. An advantage over ordinary screen separation is that the percentage solids content of the waste pulp from the centrifugal sieve is about three times that of pulp from the conventional screen. In the operation diagrammed in Fig. 15.3, the extracted pulp having 13% solids content is pressed to 23% solids and then dried to provide a component for livestock feed.

On examining the series of processing steps used in a modern potato starch factory, the average person is amazed at the multiple washings and screenings employed to obtain a final product as pure as possible but still one that sells at a relatively low price. The final purification of starch milk is carried out by passage through a battery of cylindroconical centrifugals. These compact vertical units provide efficient removal of soluble impurities and separation of the starch from the wash water by centrifugal force. Dewatering and drying are conducted by the same methods described in the section on Idaho plants.

CONVERSION OF WASTES TO BY-PRODUCTS

There are two wastes in producing potato starch that can be converted into useful by-products: (1) the extracted pulp (pomace) and (2) the soluble constituents of the protein water. For a number of years, the pomace has been dewatered and dried for sale as a feed component. Analysis of a dried pomace sample indicated the following percentage

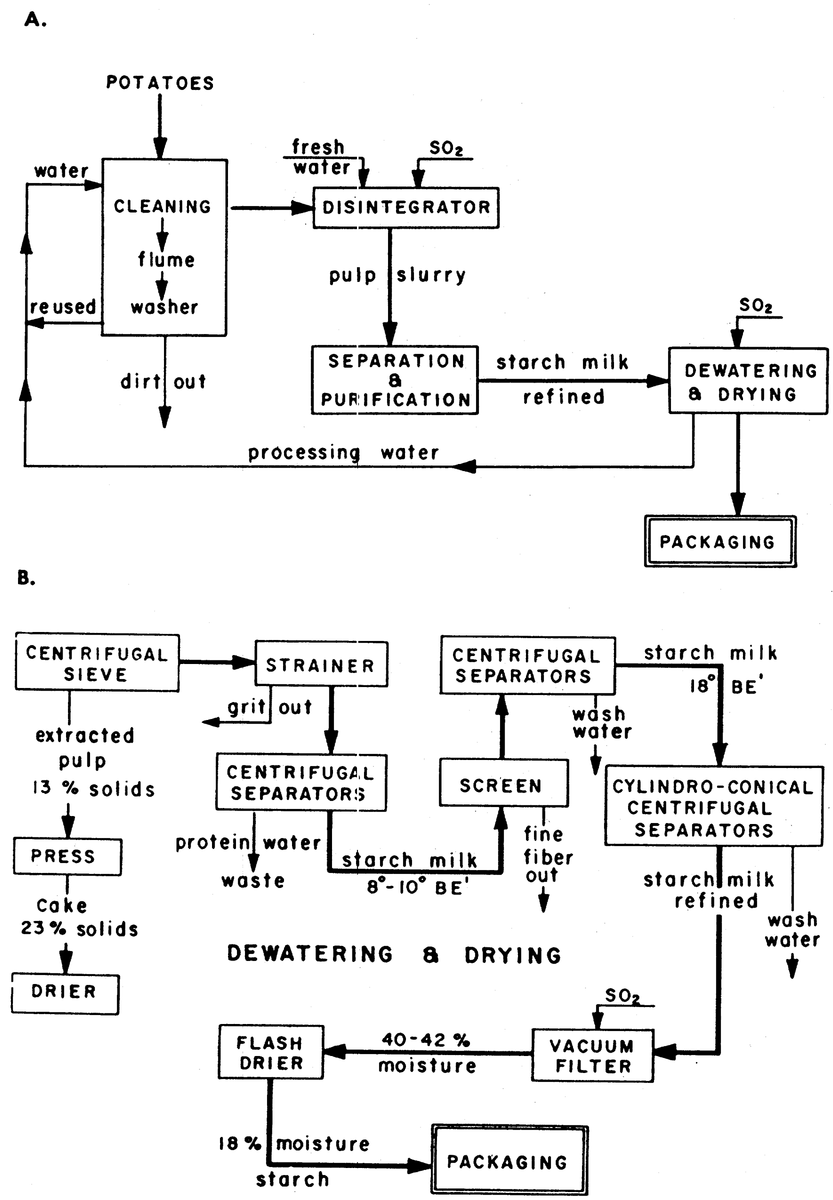

Fig. 15.3. Flow diagram of steps in modern potato starch processing plant. A—overall process; B—details of separation and purification operations.

composition; moisture, 4.5; starch, 54.6; uronic acid anhydride, 16; pectin, 12; "pentosans," 9.5; crude fiber, 15.6; ash, 1.0; fat, 0.4; protein (N × 6.25), 5.9; and sugars, trace. (The total exceeds 100% probably because of overlapping in some of the carbohydrate determinations.) About 400–450 lb of pulp solids are obtained per ton of starch produced (Howerton and Treadway 1948).

About 450–650 lb of protein water solids are obtained per ton of starch produced (Howerton and Treadway 1948). The protein water typically contains 1–3% solids. Nitrogenous compounds constitute about 60% of the total solids. Up to two-thirds of the nitrogenous constituents are free amino compounds and one-third is protein. The nonnitrogenous constituents of the protein water are sugars, organic acids, inorganic salts, and a number of minor constituents.

Laboratory studies have shown that the soluble constituents can be completely separated and recovered in five steps: (1) concentration of the dilute wastewater to about 4–5% solids using reverse osmosis or a minimum water addition during the potato maceration; (2) precipitation and recovery of the protein by steam injection or another suitable method; (3) separation and recovery of a fertilizer mixture containing potassium and other inorganic cations by ion exchange; (4) separation and recovery of amino compounds by ion exchange; and (5) recovery of organic acids (mainly citric) and phosphates by ion exchange. These five steps separate the protein water constituents; isolation of the sugars is effected by their not being adsorbed on ion-exchange columns (Heisler *et al.* 1959, 1962, 1970, 1972; Schwartz *et al.* 1972).

Strolle *et al.* (1973) showed that the proteins can be quantitatively recovered from potato starch protein water by acidifying to pH 5.5 or lower, heating to at least 99°C, pressure filtering in a plate frame filter press, and then drying on a double-drum drier. A cost analysis (Stabile *et al.* 1971) indicated, however, that protein recovery followed by removal of the other constituents using ion exchange is not economically feasible. Apparently the most economical approach is to concentrate the entire protein water effluent, dry the concentrate, and then use the product as a feed for monogastric animals or as a fermentation medium.

STARCH FRACTIONS, MODIFICATIONS, AND DERIVATIVES

In the 1950s, Dutch chemical engineers developed a successful commercial process for separating starch into its two principal components: branched-chain *amylopectin* and straight-chain, cellulose-like *amylose* (Anon. 1958). In the fractionation process the starch is first autoclaved at 155°C in 13% magnesium sulfate solution; the amylose is separated by cooling the mixture below 93°C, and most of the amylopectin is then removed from the supernatant liquid by cooling to room temperature and salting it out with additional magnesium sulfate. Potato starch, like other principal commercial starches, contains 74–78% amylopectin.

Uses for amylose are still largely in the experimental stage but it can be made into transparent, edible films with potential use for food packaging and casings. It has definite possibilities in paper sizing and coating and in textile sizing. It can also be used to prepare chemical derivatives having properties similar to commercially successful cellulose derivatives. Amylopectin is used in the sizing and coating of paper, in textile sizing, and as a thickener in foods; it has several other potential uses. At the time of its introduction, amylose was priced at 25 cents and amylopectin at 16 cents per lb in carload quantities (Anon. 1957A).

Most potato starch is sold in the native, unmodified form. For many years, however, sizable tonnages have been converted annually into dextrins by roasting and into pregelatinized starch. A few plants convert part of their production into thin-boiling starches by acid treatment and to oxidized starch, usually by sodium hypochlorite treatment. Thin-boiling starches are useful when it is desired to have higher solids content paste without raising the consistency unduly. Oxidized starch pastes are noted for their increased clarity and diminished tendency to thicken on cooling. However, oxidation under special conditions can be made to yield a product giving pastes of higher consistency than that of unmodified starch.

Several American potato starch processors have converted starch by acid hydrolysis to glucose syrup and dextrose sugar, but this has been done only in emergency situations, such as during World War II when sugars and corn were in short supply.

Oxidation of starch by periodic acid produces a specific type of oxidation to give *dialdehyde starch,* or *oxystarch.* Oxystarch can be made economically by electrolytic regeneration of periodate; by regulating the extent of treatment, products can be formed that represent a wide range of aldehyde content. Oxystarch has found limited use in the tanning of hides and imparts wet strength to paper.

Much research has been conducted on the production of starch esters (e.g., starch acetate) and ethers (e.g., allyl starch and hydroxyethyl starch). Hydroxyethyl starch gums produced by reaction of ethylene oxide with potato starch are made in rather large tonnage in The

Netherlands. At least two U. S. manufacturers produce the hydroxyethyl ether of potato starch. Some derivatives, in which only a minor part of the hydroxyl groups of the starch molecules are substituted, are available; these disperse in water to give pastes of unusually high consistency.

So-called cationic starches form a commercially important group of potato starch derivatives. Usually ethers in structure, molecules of the cationic starches possess a positive charge. Cationic potato starch is especially valuable in paper sizing because of the strong bond formed with negatively charged cellulosic fibers.

UTILIZATION OF POTATO STARCH

Before World War II, domestic potato starch nearly always sold at a higher price than cornstarch; imported potato starch at times sold at about twice the price of domestic cornstarch (Anon. 1940). For many years this price relationship restricted the use of potato starch to special applications in which its unique properties make it preferable. The availability of imported tapioca starch at a price generally competitive with cornstarch was another factor limiting the demand for potato starch during the decade preceding World War II. Imports of tapioca were interrupted during World War II. Fortunately, the domestic potato starch industry had begun to expand and modernize in the late 1930s and was able to supply sufficient starch for essential uses during the war years.

Paper

Although potato starch has valuable properties for many applications in paper manufacture, its use for years was not common, even in mills in starch-producing areas. However, expanded use in the paper industry has become the leading potato starch development.

Starch is used for four purposes in paper manufacture: (a) beater sizing, in which the cellulosic fibers are cemented together preparatory to sheet formation; (b) tub sizing, in which the preformed sheet is passed through a dilute size solution; (c) calender sizing, in which a smooth finish is imparted; and (d) surface coating, which is an optional step in finishing high-grade papers. Starches and dextrins are also used in combining and sealing paperboard in the fabrication of folding, corrugated, and laminated solid-fiber boxes.

Cold-water-soluble potato starch is outstanding in the performance in beater sizing. This modified starch is produced by cooking a suspension of starch, drying the paste on drum driers, and grinding the flakes to a powder. This type of soluble potato starch was first manufactured in The Netherlands and has been produced for years in this country to supply a steady market. Soluble potato starch, or *gum,* is preferred to the corresponding products from other starches in beater sizing because its paste possesses great stringiness and cohesive strength. Furthermore, these properties are said to be affected relatively little on addition of alum. Alum is regularly used in paper manufacture, and its acidic character is detrimental to the properties of most starch pastes.

Potato starch is well liked relative to cereal starches for coating smooth, white paper such as that used in magazines. The unusually strong binding power of potato starch for the white pigments and clay is advantageous here. Potato starch is said to have replaced much casein formerly used in paper coating.

Textiles

Most of the potato starch used in the textile industry is employed in the sizing of cotton, worsted, and spun rayon warps. In warp sizing, parallel threads that run lengthwise in the loom dip into a bath of hot starch paste formulation; the sized thread passes over heated drums to effect drying after leaving the bath. The function of warp sizing is to bind tightly the loose fibers to the surface of the thread and thereby strengthen and protect the warp from abrasion during weaving. High-count warps, containing many individual fibers spun together, are difficult to size because of small interstitial space between the fibers. Potato starch is preferred to cereal starches in warp sizing because its paste penetrates farther before gelling. Deeper penetration of the starch results in formation of a film that adheres well to the warp and consequently gives it more strength and resistance to abrasion. It is well known that potato starch films have a high degree of toughness and flexibility relative to other starches. This permits potato starch-sized warps to be woven at lower humidity than those sized with cornstarch.

The smooth clear pastes obtained with potato starch also have other advantages in warp sizing. Cereal starch pastes frequently contain large aggregates of gelled material, which stick to the warp and subsequently get caught in the loom to cause thread breakage. Warps sized with potato starch not only have a smoother finish but also are easier to desize after the size has served its purpose. The lesser tendency of potato starch pastes, in comparison to cereal starch pastes, to set back, or retrograde, to a gel is of advantage following shutdowns. It is also claimed that less tallow is required in potato starch sizes to minimize sticking of warp to drying drums than with other common starches. Potato starch is said to be superior for sizing warps that have been previously dyed in that it gives a brighter color.

The finishing of cotton sewing thread is similar to warp sizing. The thread is immersed in a finishing bath and then passed over brushes to provide a smooth finish. Many manufacturers of cotton thread use potato starch exclusively.

Potato starch is not outstanding in its ability to bring out color intensity of vat dyes when used as a thickener for textile printing pastes, but it possesses superior properties as a finishing agent. Cloth finished with potato starch has a better feel and smoother surface than is obtained with cereal starches.

Food

Much of the potato starch utilized in the food industry is used in bakers' specialty items (e.g., Swedish and German style breads), in crackers, and in matzoth. It is also used as a thickener in soups and gravies. Potato starch has been pelleted successfully to make puddings similar to those ordinarily made from tapioca starch. Pregelatinized potato starch is used in considerable quantity in instant puddings, in which its properties are preferable to those of cereal starches. The dry formulation of instant puddings is principally soluble starch, sugar, and flavoring. Upon addition of cold milk, the starch quickly dissolves and then sets to a gelled pudding.

Starch is used in the confectionery industry for the following purposes: (a) as a medium for molding cast candies such as jelly beans, "orange slices," and gum drops; (b) as a bodying agent and to impart smoothness and stability to caramels and marshmallow; (c) as a thickening agent in synthetic jellies; and (d) as a dusting agent, perhaps mixed with powdered sugar, for candy gums, chewing gum, etc. Thin-boiling starch rather than thick-boiling starch (unmodified) is ordinarily used as an ingredient in candy manufacture. Starch constitutes 10–12% of the total weight of dry ingredients in candy gums. Glucose syrup, produced by the hydrolysis of starch, is widely used in candies, beverages, chewing gum, ice cream, and confections in general.

Adhesives

In producing adhesives, it is generally advantageous to use starch that has been subjected to chemical or physical treatment to reduce its paste viscosity, thereby permitting use of higher solids concentration, and to develop so-called tackiness. Although some thin-boiling and oxidized starches are used in adhesives, generally the dextrinized form is used for this purpose. Dextrins are produced by roasting starch in the presence of an acid catalyst. Films of dextrin made from root and tuber starches, such as tapioca, sweet potato, and potato, have greater flexibility and resistance to checking than dextrins of cereal starches. Potato dextrins are used in many applications in which their specific properties make them desirable, for example, as a binder in sand paper, abrasive cloth, bookbinding, and rug sizing, each of which requires a dextrin of high paste tackiness and of flexible residual film. Potato dextrin films are also outstanding for their ease in remoistening; this property is desired in mucilages used for gumming stamps, labels, envelopes, paper tape, etc.

Miscellaneous Uses

Miscellaneous uses of starch include the following: (a) hygroscopic additive in baking powder; (b) fermentation raw material; (c) binder for tablets; (d) binder and extender for sausages; (e) builder for soap; (f) separator in dry cell batteries; (g) raw material for nitro-starch manufacture; (h) consistency stabilizer for oil well drilling "muds"; (i) attractant in insecticidal mixtures; (j) boiler feed water treating agent; and (k) clarifying agent for waters used in mining operations. Potato starch is undoubtedly used for some of these purposes. However, manufacturers and distributors of potato starch, for business reasons, hold as confidential information concerning some of the lesser uses of their product.

OUTLOOK FOR POTATO STARCH

The potato starch industry has made great strides in improving technology to produce high-quality starch by streamlined methods. The demand constantly exists for large quantities of potato starch because of its unique properties. The problem lies in obtaining raw material at a price that permits processors to produce potato starch at a cost that is competitive with other starches. If future potato crops are sufficiently large to provide amply for food needs, with substandard raw material to spare, then the starchmaker will have plant input. The return from recovered by-products plus the margin realized from the starch itself must make the overall operation profitable.

More than half of the potatoes consumed as food are now manufactured into various processed forms. Much starch is freed in the slicing and washing of sliced potatoes undergoing food processing. Peelings and trimmings are sources of large amounts of starch. This starch must not enter the waterways as an eventual pollutant. Perhaps in the future, a good part of our potato starch production will be as a result of its recovery in conjunction with other operations in large food-processing plants.

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